

# Appendix C1: Life History Parameter Values Used to Evaluate I&E in the North Atlantic Region

The tables in this appendix present the life history parameter values used by EPA to calculate age 1 equivalents, fishery yields, and production foregone from I&E data for the North Atlantic Region. Because of differences in the number of life stages represented in the loss data, there are cases where more than one life stage sequence was needed for a given species or species group. Alternative parameter sets were developed for this purpose and are indicated with a number following the species or species group name (i.e., Winter flounder 1, Winter flounder 2).

<b>Table C1-1: Alewife Life History Parameters</b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	0.544	0	0	0.00000128
Larvae	5.50	0	0	0.00000141
Juvenile	2.57	0	0	0.00478
Age 1+	1.04	0	0	0.0443
Age 2+	1.04	0	0	0.139
Age 3+	1.04	0	0	0.264
Age 4+	1.04	0	0	0.386
Age 5+	1.04	0	0	0.489
Age 6+	1.04	0	0	0.568
Age 7+	1.04	0	0	0.626
Age 8+	1.04	0	0	0.667
Age 9+	1.04	0	0	0.696

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-2: American Plaice Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.0000115
Larvae	8.22	0	0	0.0000126
Juvenile	0.916	0	0	0.000110
Age 1+	0.200	0	0	0.00903
Age 2+	0.200	0.32	0.50	0.0871
Age 3+	0.200	0.32	1.0	0.190
Age 4+	0.200	0.32	1.0	0.328
Age 5+	0.200	0.32	1.0	0.494
Age 6+	0.200	0.32	1.0	0.711
Age 7+	0.200	0.32	1.0	0.986
Age 8+	0.200	0.32	1.0	1.24
Age 9+	0.200	0.32	1.0	1.53
Age 10+	0.200	0.32	1.0	1.86
Age 11+	0.200	0.32	1.0	2.24
Age 12+	0.200	0.32	1.0	2.68
Age 13+	0.200	0.32	1.0	3.17
Age 14+	0.200	0.32	1.0	3.52
Age 15+	0.200	0.32	1.0	3.91
Age 16+	0.200	0.32	1.0	4.32
Age 17+	0.200	0.32	1.0	4.77
Age 18+	0.200	0.32	1.0	5.24
Age 19+	0.200	0.32	1.0	5.75
Age 20+	0.200	0.32	1.0	6.28
Age 21+	0.200	0.32	1.0	6.86
Age 22+	0.200	0.32	1.0	7.46
Age 23+	0.200	0.32	1.0	8.11
Age 24+	0.200	0.32	1.0	8.44
Age 25+	0.200	0.32	1.0	8.55

Sources: Froese and Pauly, 2001; Schultz, 2000; NOAA, 1993; O'Brien, 2000; Scott and Scott, 1988; and Stone & Webster Engineering Corporation, 1977.

**Table C1-3: American Sand Lance Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.41	0	0	0.00000126
Larvae	2.97	0	0	0.00000139
Juvenile	2.90	0	0	0.00119
Age 1+	1.89	0	0	0.00384
Age 2+	0.364	0	0	0.00730
Age 3+	0.364	0	0	0.0113
Age 4+	0.364	0	0	0.0153
Age 5+	0.364	0	0	0.0191
Age 6+	0.364	0	0	0.0225
Age 7+	0.720	0	0	0.0255
Age 8+	0.720	0	0	0.0280
Age 9+	0.720	0	0	0.0301
Age 10+	0.720	0	0	0.0319
Age 11+	0.720	0	0	0.0333

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-4: American Shad Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.496	0	0	0.000000716
Yolksac larvae	0.496	0	0	0.000000728
Post-yolksac larvae	2.52	0	0	0.00000335
Juvenile	7.40	0	0	0.000746
Age 1+	0.300	0	0	0.309
Age 2+	0.300	0	0	1.17
Age 3+	0.300	0	0	2.32
Age 4+	0.540	0.21	0.45	3.51
Age 5+	1.02	0.21	0.90	4.56
Age 6+	1.50	0.21	1.0	5.47
Age 7+	1.50	0.21	1.0	6.20
Age 8+	1.50	0.21	1.0	6.77

Sources: Able and Fahay, 1998; Froese and Pauly, 2001; PSE&G, 1999; and U.S. Fish and Wildlife Services, 1978.

**Table C1-5: Atlantic Cod Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	4.87	0	0	0.00000567
Larvae	5.83	0	0	0.00000624
Juvenile	0.916	0	0	0.000337
Age 1+	0.400	0	0	0.0225
Age 2+	0.200	0.29	0.50	0.245
Age 3+	0.200	0.29	1.0	0.628
Age 4+	0.200	0.29	1.0	1.29
Age 5+	0.200	0.29	1.0	2.45
Age 6+	0.200	0.29	1.0	3.33

Sources: Entergy Nuclear Generation Company, 2000; Froese and Pauly, 2001, 2003; Mayo and O'Brien, 2000; NOAA, 2001c; and Scott and Scott, 1988.

**Table C1-6: Atlantic Herring Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	3.36	0	0	0.00000473
Larvae	3.26	0	0	0.00000531
Juvenile	3.26	0	0	0.00126
Age 1+	0.200	0.28	0.50	0.0314
Age 2+	0.200	0.28	1.0	0.173
Age 3+	0.200	0.28	1.0	0.302
Age 4+	0.200	0.28	1.0	0.420
Age 5+	0.200	0.28	1.0	0.463
Age 6+	0.200	0.28	1.0	0.525
Age 7+	0.200	0.28	1.0	0.588
Age 8+	0.200	0.28	1.0	0.642
Age 9+	0.200	0.28	1.0	0.699
Age 10+	0.200	0.28	1.0	0.732
Age 11+	0.200	0.28	1.0	0.766
Age 12+	0.200	0.28	1.0	0.848
Age 13+	0.200	0.28	1.0	0.855
Age 14+	0.200	0.28	1.0	0.862
Age 15+	0.200	0.28	1.0	0.869
Age 16+	0.200	0.28	1.0	0.877

<sup>a</sup> Includes Atlantic herring, hickory shad, round herring, and other herring not identified to species.

Sources: Able and Fahay, 1998; ASMFC, 2001a; Entergy Nuclear Generation Company, 2000; Froese and Pauly, 2001; NOAA, 2001c; Overholtz, 2002a; and Scott and Scott, 1988.

<b>Table C1-7: Atlantic Mackerel Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.39	0	0	0.00000176
Larvae	5.30	0	0	0.00000193
Juvenile	5.30	0	0	0.000833
Age 1+	0.520	0	0	0.309
Age 2+	0.370	0.25	0.50	0.510
Age 3+	0.370	0.25	1.0	0.639
Age 4+	0.370	0.25	1.0	0.752
Age 5+	0.370	0.25	1.0	0.825
Age 6+	0.370	0.25	1.0	0.918
Age 7+	0.370	0.25	1.0	1.02
Age 8+	0.370	0.25	1.0	1.10
Age 9+	0.370	0.25	1.0	1.13
Age 10+	0.370	0.25	1.0	1.15
Age 11+	0.370	0.25	1.0	1.22
Age 12+	0.370	0.25	1.0	1.22
Age 13+	0.370	0.25	1.0	1.22
Age 14+	0.370	0.25	1.0	1.22

Sources: Entergy Nuclear Generation Company, 2000; Froese and Pauly, 2001, 2003; NOAA, 2001c; Overholtz et al., 1991; Overholtz 2002b; Scott and Scott, 1988; and Studholme et al., 1999.

<b>Table C1-8: Atlantic Menhaden Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.20	0	0	0.00000482
Larvae	4.47	0	0	0.00000530
Juvenile	6.19	0	0	0.000684
Age 1+	0.540	0	0	0.0251
Age 2+	0.450	1.1	1.0	0.235
Age 3+	0.450	1.1	1.0	0.402
Age 4+	0.450	1.1	1.0	0.586
Age 5+	0.450	1.1	1.0	0.863
Age 6+	0.450	1.1	1.0	1.08
Age 7+	0.450	1.1	1.0	1.27
Age 8+	0.450	1.1	1.0	1.43

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-9: Atlantic Silverside Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.41	0	0	0.00000473
Larvae	5.81	0	0	0.00000520
Juvenile 1	2.63	0	0	0.00490
Age 1+	3.00	0	0	0.0205
Age 2+	6.91	0	0	0.0349

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-10: Atlantic Tomcod Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	8.46	0	0	0.00000126
Larvae	8.46	0	0	0.0000185
Juvenile	8.46	0	0	0.0145
Age 1+	8.46	0	0	0.0804
Age 2+	2.83	0	0	0.270
Age 3+	2.83	0	0	0.486

Sources: McLaren et al., 1988; NMFS, 2003a; Stewart and Auster, 1987; and Virginia Tech, 1998.

**Table C1-11: Bay Anchovy Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.10	0	0	0.000000517
Larvae	7.19	0	0	0.000000569
Juvenile	2.09	0	0	0.00104
Age 1+	2.30	0	0	0.00370
Age 2+	2.30	0	0	0.00765
Age 3+	2.30	0	0	0.0126

<sup>a</sup> Includes bay anchovy, striped anchovy, and other anchovies not identified to species.

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-12: Blueback Herring Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.558	0	0	0.00000115
Yolksac larvae	1.83	0	0	0.00321
Post-yolksac larvae	1.74	0	0	0.00640
Juvenile 1	3.13	0	0	0.00959
Juvenile 2	3.13	0	0	0.0128
Age 1+	0.300	0	0	0.0160
Age 2+	0.300	0	0	0.0905
Age 3+	0.300	0	0	0.204
Age 4+	0.900	0	0	0.318
Age 5+	1.50	0	0	0.414
Age 6+	1.50	0	0	0.488
Age 7+	1.50	0	0	0.540
Age 8+	1.50	0	0	0.576

Sources: PSE&G, 1999; and PG&E National Energy Group, 2001.

**Table C1-13: Bluefish Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.35	0	0	0.0000123
Larvae	8.24	0	0	0.0000135
Juvenile	5.07	0.06	1.0	0.194
Age 1+	0.350	0.28	1.0	1.06
Age 2+	0.350	0.28	1.0	2.81
Age 3+	0.350	0.28	1.0	5.21
Age 4+	0.350	0.28	1.0	7.95
Age 5+	0.350	0.28	1.0	10.7
Age 6+	0.350	0.28	1.0	13.4
Age 7+	0.350	0.28	1.0	15.9
Age 8+	0.350	0.28	1.0	18.0
Age 9+	0.350	0.28	1.0	19.9
Age 10+	0.350	0.28	1.0	21.6
Age 11+	0.350	0.28	1.0	22.9
Age 12+	0.350	0.28	1.0	24.1
Age 13+	0.350	0.28	1.0	25.0
Age 14+	0.350	0.28	1.0	25.8

Sources: PG&E National Energy Group, 2001; and Wang, 1979.

**Table C1-14: Butterfish Life History Parameters**

Stage Name	Natural Mortality	Fishing Mortality	Fraction Vulnerable	Weight
Eggs	2.30	0	0	0.000000396
Larvae	6.64	0	0	0.000000436
Juvenile	0.916	0	0	0.000251
Age 1+	0.800	0.28	0.50	0.0272
Age 2+	0.800	0.28	1.0	0.0986
Age 3+	0.800	0.28	1.0	0.944

Sources: Able and Fahay, 1998; Froese and Pauly, 2001; NOAA, 2001b; Scott and Scott, 1988; and Stone & Webster Engineering Corporation, 1977.

**Table C1-15: Commercial Crab Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Megalops	1.30	0	0	0.00000291
Juvenile	1.73	0.48	0.50	0.00000293
Age 1+	1.10	0.48	1.0	0.00719
Age 2+	1.38	0.48	1.0	0.113
Age 3+	1.27	0.48	1.0	0.326

<sup>a</sup> Includes green crab, jonah crab, lady crab, lesser blue crab, narrow mud crab, and spider crab.

Sources: Hartman, 1993; and PSE&G, 1999.

**Table C1-16: Cunner Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	3.49	0	0	0.000000787
Larvae	2.90	0	0	0.00000236
Juvenile	2.90	0	0	0.0000814
Age 1+	0.831	0	0	0.00311
Age 2+	0.831	0.10	0.50	0.0246
Age 3+	0.286	0.10	1.0	0.0749
Age 4+	0.342	0.10	1.0	0.145
Age 5+	0.645	0.10	1.0	0.229
Age 6+	1.26	0.10	1.0	0.624

Sources: Able and Fahay, 1998; Entergy Nuclear Generation Company, 2000; Scott and Scott, 1988; and Serchuk and Cole, 1974.

<b>Table C1-17: Fourbeard Rockling Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.000000637
Larvae	4.25	0	0	0.000000700
Juvenile	0.916	0	0	0.00187
Age 1+	0.490	0	0	0.0142
Age 2+	0.490	0	0	0.0209
Age 3+	0.490	0	0	0.0402
Age 4+	0.490	0	0	0.0617
Age 5+	0.490	0	0	0.0906
Age 6+	0.490	0	0	0.151
Age 7+	0.490	0	0	0.188
Age 8+	0.490	0	0	0.251
Age 9+	0.490	0	0	0.323

Sources: Deree, 1999; Froese and Pauly, 2001, 2003; and NMFS, 2003a.

<b>Table C1-18: Grubby Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.00000473
Larvae	3.79	0	0	0.00000520
Juvenile	0.916	0	0	0.0000197
Age 1+	0.460	0	0	0.00633
Age 2+	0.460	0	0	0.0115
Age 3+	0.460	0	0	0.0190
Age 4+	0.460	0	0	0.0292
Age 5+	0.460	0	0	0.0424
Age 6+	0.460	0	0	0.0592
Age 7+	0.460	0	0	0.0799
Age 8+	0.460	0	0	0.105
Age 9+	0.460	0	0	0.135

Sources: Able and Fahay, 1998; Clayton et al., 1978; Froese and Pauly, 2001, 2003; NMFS, 2003a; and Scott and Scott, 1988.

**Table C1-19: Hogchoker Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.04	0	0	0.000000487
Larvae	5.20	0	0	0.00110
Juvenile	2.31	0	0	0.00207
Age 1+	2.56	0	0	0.0113
Age 2+	0.705	0	0	0.0313
Age 3+	0.705	0	0	0.0610
Age 4+	0.705	0	0	0.0976
Age 5+	0.705	0	0	0.138
Age 6+	0.705	0	0	0.178

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-20: Lumpfish Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.00000317
Larvae	8.48	0	0	0.0000169
Juvenile	0.916	0	0	0.00472
Age 1+	0.190	0.26	0.50	0.0138
Age 2+	0.190	0.26	1.0	0.0573
Age 3+	0.190	0.26	1.0	0.149
Age 4+	0.190	0.26	1.0	0.686
Age 5+	0.190	0.26	1.0	1.86

Sources: Able and Fahay, 1998; Bigelow and Schroeder, 1953; Froese and Pauly, 2001; NMFS, 2003a; and Scott and Scott, 1988.

**Table C1-21: Northern Pipefish Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.000000773
Larvae	2.40	0	0	0.0000122
Juvenile	0.916	0	0	0.00785
Age 1+	0.750	0	0	0.0151
Age 2+	0.750	0	0	0.0180
Age 3+	0.750	0	0	0.0212
Age 4+	0.750	0	0	0.0247
Age 5+	0.750	0	0	0.0285

Sources: Able and Fahay, 1998; Froese and Pauly, 2001; NMFS, 2003a; and Scott and Scott, 1988.

<b>Table C1-22: Pollock Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.922	0	0	0.00000154
Larvae	4.07	0	0	0.00000169
Juvenile	6.93	0	0	0.00166
Age 1+	0.200	0	0	0.657
Age 2+	0.200	0.20	0.50	1.30
Age 3+	0.200	0.20	1.0	1.73
Age 4+	0.200	0.20	1.0	3.24
Age 5+	0.200	0.20	1.0	4.93
Age 6+	0.200	0.20	1.0	5.70
Age 7+	0.200	0.20	1.0	6.83
Age 8+	0.200	0.20	1.0	8.46
Age 9+	0.200	0.20	1.0	9.93
Age 10+	0.200	0.20	1.0	12.0
Age 11+	0.200	0.20	1.0	14.8
Age 12+	0.200	0.20	1.0	16.4
Age 13+	0.200	0.20	1.0	18.1
Age 14+	0.200	0.20	1.0	19.9
Age 15+	0.200	0.20	1.0	21.2

Sources: Able and Fahay, 1998; Froese and Pauly, 2001; NOAA, 2001c; and Sails et al., 1997.

<b>Table C1-23: Radiated Shanny Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.00000430
Larvae	2.20	0	0	0.00000473
Juvenile	0.916	0	0	0.0000559
Age 1+	0.440	0	0	0.000472
Age 2+	0.440	0	0	0.00163
Age 3+	0.440	0	0	0.00374
Age 4+	0.440	0	0	0.00719
Age 5+	0.440	0	0	0.00988
Age 6+	0.440	0	0	0.0132
Age 7+	0.440	0	0	0.0258
Age 8+	0.440	0	0	0.0448

Sources: Froese and Pauly, 2001; NMFS, 2003a; Pepin et al., 2002; and Scott and Scott, 1988.

**Table C1-24: Rainbow Smelt Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	4.44	0	0	0.000000990
Larvae	3.12	0	0	0.00110
Juvenile	1.39	0	0	0.00395
Age 1+	1.00	0	0	0.0182
Age 2+	1.00	0	0	0.0460
Age 3+	1.00	0	0	0.0850
Age 4+	1.00	0	0	0.131
Age 5+	1.00	0	0	0.180
Age 6+	1.00	0	0	0.228

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-25: Red Hake Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.22	0	0	0.000000487
Larvae 2mm	0.670	0	0	0.000000536
Larvae 2.5mm	0.670	0	0	0.000000589
Larvae 3.0mm	0.670	0	0	0.000000744
Larvae 3.5mm	0.670	0	0	0.00000118
Larvae 4.0mm	0.670	0	0	0.00000176
Larvae 4.5mm	3.35	0	0	0.00000251
Juvenile	4.83	0	0	0.00345
Age 1+	0.400	0.39	0.50	0.231
Age 2+	0.400	0.39	1.0	0.805
Age 3+	0.400	0.39	1.0	0.991
Age 4+	0.400	0.39	1.0	1.22
Age 5+	0.400	0.39	1.0	1.55
Age 6+	0.400	0.39	1.0	1.93
Age 7+	0.400	0.39	1.0	2.36
Age 8+	0.400	0.39	1.0	2.86
Age 9+	0.400	0.39	1.0	3.42
Age 10+	0.400	0.39	1.0	3.66

<sup>a</sup> Includes red hake, spotted hake, and white hake.

Sources: Able & Fahay, 1998; Froese and Pauly, 2001; NOAA, 2001c; Sailsa et al., 1997; and Scott and Scott, 1988.

<b>Table C1-26: Rock Gunnel Life History Parameters</b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	2.30	0	0	0.00000924
Larvae	1.66	0	0	0.0000102
Juvenile	0.916	0	0	0.000701
Age 1+	0.440	0	0	0.00382
Age 2+	0.440	0	0	0.0128
Age 3+	0.440	0	0	0.0223
Age 4+	0.440	0	0	0.0371
Age 5+	0.440	0	0	0.0490

Sources: Froese and Pauly, 2001; NMFS, 2003a; and Scott and Scott, 1988.

<b>Table C1-27: Sculpin Life History Parameters<sup>a</sup></b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	2.30	0	0	0.0000107
Larvae	3.79	0	0	0.0000118
Juvenile	0.916	0	0	0.000754
Age 1+	0.460	0.50	0.50	0.00404
Age 2+	0.460	0.50	1.0	0.139
Age 3+	0.460	0.50	1.0	0.332
Age 4+	0.460	0.50	1.0	0.420
Age 5+	0.460	0.50	1.0	0.475
Age 6+	0.460	0.50	1.0	0.541
Age 7+	0.460	0.50	1.0	0.576
Age 8+	0.460	0.50	1.0	0.612
Age 9+	0.460	0.50	1.0	0.637

<sup>a</sup> Includes longhorn sculpin, moustache sculpin, shorthorn sculpin, and other sculpin not identified to species.

Sources: Clayton et al., 1978; Froese and Pauly, 2001; Scott and Scott, 1988; and personal communication with Y. DeReynier (NMFS, November 19, 2002).

<b>Table C1-28: Scup Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.43	0	0	0.000000773
Larvae	4.55	0	0	0.00110
Juvenile	3.36	0	0	0.0280
Age 1+	0.383	0	0	0.132
Age 2+	0.383	0	0	0.322
Age 3+	0.383	0.26	1.0	0.572
Age 4+	0.383	0.26	1.0	0.845
Age 5+	0.383	0.26	1.0	1.12
Age 6+	0.383	0.26	1.0	1.37
Age 7+	0.383	0.26	1.0	1.59
Age 8+	0.383	0.26	1.0	1.78
Age 9+	0.383	0.26	1.0	1.94
Age 10+	0.383	0.26	1.0	2.07
Age 11+	0.383	0.26	1.0	2.23

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

<b>Table C1-29: Seaboard Goby Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.288	0	0	0.0000164
Larvae	4.09	0	0	0.0000180
Juvenile	2.30	0	0	0.000485
Age 1+	2.55	0	0	0.00205

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

<b>Table C1-30: Searobin Life History Parameters<sup>a</sup></b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.30	0	0	0.00000132
Larvae	3.66	0	0	0.00000145
Juvenile	0.916	0	0	0.000341
Age 1+	0.420	0.10	0.50	0.0602
Age 2+	0.420	0.10	1.0	0.176
Age 3+	0.420	0.10	1.0	0.267
Age 4+	0.420	0.10	1.0	0.386
Age 5+	0.420	0.10	1.0	0.537
Age 6+	0.420	0.10	1.0	0.721
Age 7+	0.420	0.10	1.0	0.944
Age 8+	0.420	0.10	1.0	1.21

<sup>a</sup> Includes northern searobin, striped searobin, and other searobin not identified to species.

Sources: Entergy Nuclear Generation Company, 2000; Froese and Pauly, 2001, 2003; and Virginia Tech, 1998.

<b>Table C1-31: Silver Hake Life History Parameters</b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.43	0	0	0.0000203
Larvae	6.62	0	0	0.0000223
Juvenile	4.58	0	0	0.00516
Age 1+	0.400	0	0	0.0729
Age 2+	0.400	0	0	0.242
Age 3+	0.400	0.40	1.0	0.456
Age 4+	0.400	0.40	1.0	0.646
Age 5+	0.400	0.40	1.0	0.788
Age 6+	0.400	0.40	1.0	0.889
Age 7+	0.400	0.40	1.0	0.958
Age 8+	0.400	0.40	1.0	1.00
Age 9+	0.400	0.40	1.0	1.03
Age 10+	0.400	0.40	1.0	1.05
Age 11+	0.400	0.40	1.0	1.06
Age 12+	0.400	0.40	1.0	1.06

Source: PG&E National Energy Group, 2001.

<b>Table C1-32: Skate Species Life History Parameters<sup>a</sup></b>				
Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	3.00	0	0	0.0125
Larvae	2.30	0	0	0.0138
Juvenile	0.916	0	0	0.0593
Age 1+	0.400	0.40	0.50	0.157
Age 2+	0.400	0.40	1.0	0.394
Age 3+	0.400	0.40	1.0	0.750
Age 4+	0.400	0.40	1.0	1.15
Age 5+	0.400	0.40	1.0	1.51
Age 6+	0.400	0.40	1.0	1.62
Age 7+	0.400	0.40	1.0	1.65
Age 8+	0.400	0.40	1.0	1.72

<sup>a</sup> Includes clearnose skate, little skate and other skates not identified to level.

Sources: Froese and Pauly, 2000; NOAA, 1993, 2001c; and Scott and Scott, 1988.

**Table C1-33: Striped Bass Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.28	0	0	0.0000282
Larvae	6.28	0	0	0.0000310
Juvenile	5.63	0	0	0.0405
Age 1+	1.11	0	0	0.386
Age 2+	0.150	0.02	1.0	1.37
Age 3+	0.150	0.06	1.0	3.06
Age 4+	0.150	0.20	1.0	5.35
Age 5+	0.150	0.29	1.0	8.07
Age 6+	0.150	0.31	1.0	11.0
Age 7+	0.150	0.31	1.0	14.1
Age 8+	0.150	0.31	1.0	17.1
Age 9+	0.150	0.31	1.0	20.0
Age 10+	0.150	0.31	1.0	22.8
Age 11+	0.150	0.31	1.0	25.3
Age 12+	0.150	0.31	1.0	27.6
Age 13+	0.150	0.31	1.0	29.7
Age 14+	0.150	0.31	1.0	31.6
Age 15+	0.150	0.31	1.0	33.3
Age 16+	0.150	0.31	1.0	34.7
Age 17+	0.150	0.31	1.0	36.0
Age 18+	0.150	0.31	1.0	37.2
Age 19+	0.150	0.31	1.0	38.2
Age 20+	0.150	0.31	1.0	39.0
Age 21+	0.150	0.31	1.0	39.8
Age 22+	0.150	0.31	1.0	40.4
Age 23+	0.150	0.31	1.0	41.0
Age 24+	0.150	0.31	1.0	41.5

Source: PG&E National Energy Group, 2001.

<b>Table C1-34: Striped Killifish Life History Parameters<sup>a</sup></b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	2.30	0	0	0.0000180
Larvae	3.00	0	0	0.0000182
Juvenile	0.916	0	0	0.000157
Age 1+	0.777	0	0	0.0121
Age 2+	0.777	0	0	0.0327
Age 3+	0.777	0	0	0.0551
Age 4+	0.777	0	0	0.0778
Age 5+	0.777	0	0	0.0967
Age 6+	0.777	0	0	0.113
Age 7+	0.777	0	0	0.158

<sup>a</sup> Includes mummichog, striped killifish, and other killifish not identified to species.

Sources: Able and Fahay, 1998; Carlander, 1969; Meredith and Lotrich, 1979; and NMFS, 2003a.

**Table C1-35: Tautog Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.40	0	0	0.00000123
Larvae	5.86	0	0	0.0221
Juvenile	5.02	0	0	0.0637
Age 1+	0.175	0	0	0.217
Age 2+	0.175	0	0	0.440
Age 3+	0.175	0	0	0.734
Age 4+	0.175	0	0	1.08
Age 5+	0.175	0	0	1.48
Age 6+	0.175	0	0	1.89
Age 7+	0.175	0	0	2.32
Age 8+	0.175	0	0	2.76
Age 9+	0.175	0.24	1.0	3.18
Age 10+	0.175	0.24	1.0	3.60
Age 11+	0.175	0.24	1.0	4.00
Age 12+	0.175	0.24	1.0	4.38
Age 13+	0.175	0.24	1.0	4.73
Age 14+	0.175	0.24	1.0	5.07
Age 15+	0.175	0.24	1.0	5.38
Age 16+	0.175	0.24	1.0	5.67
Age 17+	0.175	0.24	1.0	5.94
Age 18+	0.175	0.24	1.0	6.19
Age 19+	0.175	0.24	1.0	6.42
Age 20+	0.175	0.24	1.0	6.63
Age 21+	0.175	0.24	1.0	6.82
Age 22+	0.175	0.24	1.0	6.99
Age 23+	0.175	0.24	1.0	7.15
Age 24+	0.175	0.24	1.0	10.0

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

**Table C1-36: Threespine Stickleback Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.288	0	0	0.00000567
Larvae	2.12	0	0	0.00110
Juvenile	1.70	0	0	0.00377
Age 1+	1.42	0	0	0.00917
Age 2+	1.42	0	0	0.0112
Age 3+	1.42	0	0	0.0116

<sup>a</sup> Includes blackspotted stickleback, fourspine stickleback, ninespine stickleback, threespine stickleback, and other stickleback not identified to species.

Sources: PG&E National Energy Group, 2001; and Wang, 1986.

**Table C1-37: Weakfish Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.498	0	0	0.00000115
Larvae	2.84	0	0	0.0650
Juvenile 1	3.39	0	0	0.130
Juvenile 2	5.47	0	0	0.195
Age 1+	0.694	0.25	1.0	0.260
Age 2+	0.730	0.50	1.0	0.680
Age 3+	0.657	0.50	1.0	1.12
Age 4+	0.511	0.50	1.0	1.79
Age 5+	0.511	0.50	1.0	2.91
Age 6+	0.511	0.50	1.0	6.21
Age 7+	0.511	0.50	1.0	7.14
Age 8+	0.511	0.50	1.0	9.16
Age 9+	0.511	0.50	1.0	10.8
Age 10+	0.511	0.50	1.0	12.5
Age 11+	0.511	0.50	1.0	12.5
Age 12+	0.511	0.50	1.0	12.5
Age 13+	0.511	0.50	1.0	12.5
Age 14+	0.511	0.50	1.0	12.5
Age 15+	0.511	0.50	1.0	12.5

<sup>a</sup> Includes northern kingcroaker and weakfish.

Sources: Froese and Pauly, 2003; PG&E National Energy Group, 2001; and PSE&G, 1999.

**Table C1-38: White Perch Life History Parameters**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.42	0	0	0.000000842
Larvae	4.59	0	0	0.00110
Juvenile	9.06	0	0	0.00302
Age 1+	0.693	0	0	0.0516
Age 2+	0.693	0	0	0.156
Age 3+	0.543	0.15	1.0	0.248
Age 4+	0.543	0.15	1.0	0.331
Age 5+	1.46	0.15	1.0	0.423
Age 6+	1.46	0.15	1.0	0.523
Age 7+	1.46	0.15	1.0	0.613
Age 8+	1.46	0.15	1.0	0.658
Age 9+	1.46	0.15	1.0	0.794

Sources: PG&E National Energy Group, 2001; and Stanley and Danie, 1983.

**Table C1-39: Windowpane Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	1.41	0	0	0.00000154
Larvae	6.99	0	0	0.00165
Juvenile	2.98	0	0	0.00223
Age 1+	0.420	0	0	0.0325
Age 2+	0.420	0	0	0.122
Age 3+	0.420	0	0	0.265
Age 4+	0.420	0	0	0.433
Age 5+	0.420	0	0	0.603
Age 6+	0.420	0.10	1.0	0.761
Age 7+	0.420	0.10	1.0	0.899
Age 8+	0.420	0.10	1.0	1.01
Age 9+	0.420	0.10	1.0	1.11
Age 10+	0.420	0.10	1.0	1.19

<sup>a</sup> Includes American fourspot flounder, smallmouth flounder, summer flounder, and windowpane.

Sources: Froese and Pauly, 2003; and PG&E National Energy Group, 2001.

<b>Table C1-40: Winter Flounder Life History Parameters 1<sup>a,b</sup></b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	0.288	0	0	0.00000115
Larvae 1	2.05	0	0	0.00441
Larvae 2	3.42	0	0	0.0110
Larvae 3	3.52	0	0	0.0176
Larvae 4	0.177	0	0	0.0221
Juvenile	2.38	0	0	0.0330
Age 1+	1.10	0.0066	1.0	0.208
Age 2+	0.924	0.082	1.0	0.562
Age 3+	0.200	0.20	1.0	0.997
Age 4+	0.200	0.33	1.0	1.42
Age 5+	0.200	0.33	1.0	1.78
Age 6+	0.200	0.33	1.0	2.07
Age 7+	0.200	0.33	1.0	2.29
Age 8+	0.200	0.33	1.0	2.45
Age 9+	0.200	0.33	1.0	2.57
Age 10+	0.200	0.33	1.0	2.65
Age 11+	0.200	0.33	1.0	2.71
Age 12+	0.200	0.33	1.0	2.75
Age 13+	0.200	0.33	1.0	2.78
Age 14+	0.200	0.33	1.0	2.80
Age 15+	0.200	0.33	1.0	2.82
Age 16+	0.200	0.33	1.0	2.83

<sup>a</sup> Includes winter flounder, yellowtail founder, and other flounder not identified to species.

<sup>b</sup> Life history parameters applied to losses from Pilgrim, Brayton Point, and Millstone.

Sources: Able and Fahay, 1998; and PG&E National Energy Group, 2001.

**Table C1-41: Winter Flounder Life History Parameters 2<sup>a,b</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	0.288	0	0	0.00000115
Larvae 3.0 mm	0.705	0	0	0.00000127
Larvae 3.5 mm	0.705	0	0	0.00000137
Larvae 4.0 mm	0.705	0	0	0.00000146
Larvae 4.5 mm	0.705	0	0	0.00000156
Larvae 5.0 mm	0.705	0	0	0.00000216
Larvae 5.5 mm	0.705	0	0	0.00000291
Larvae 6.0 mm	0.705	0	0	0.00000382
Larvae 6.5 mm	0.705	0	0	0.00000489
Larvae 7.0 mm	0.705	0	0	0.00000616
Larvae 7.5 mm	0.705	0	0	0.00000764
Larvae 8.0 mm	0.705	0	0	0.00000933
Larvae 8.5 mm	0.705	0	0	0.0000113
Larvae 9.0 mm	0.705	0	0	0.0000135
Juvenile	2.38	0	0	0.0330
Age 1+	1.10	0.0066	1.0	0.208
Age 2+	0.924	0.082	1.0	0.562
Age 3+	0.200	0.20	1.0	0.997
Age 4+	0.200	0.33	1.0	1.42
Age 5+	0.200	0.33	1.0	1.78
Age 6+	0.200	0.33	1.0	2.07
Age 7+	0.200	0.33	1.0	2.29
Age 8+	0.200	0.33	1.0	2.45
Age 9+	0.200	0.33	1.0	2.57
Age 10+	0.200	0.33	1.0	2.65
Age 11+	0.200	0.33	1.0	2.71
Age 12+	0.200	0.33	1.0	2.75
Age 13+	0.200	0.33	1.0	2.78
Age 14+	0.200	0.33	1.0	2.80
Age 15+	0.200	0.33	1.0	2.82
Age 16+	0.200	0.33	1.0	2.83

<sup>a</sup> Includes winter flounder, witch flounder, and other flounder not identified to species.<sup>b</sup> Life history parameters applied to losses from Seabrook.

Sources: Able and Fahay, 1998; Colarusso, 2000; PG&amp;E National Energy Group, 2001; and Sails et al., 1997.

<b>Table C1-42: Winter Flounder Life History Parameters 3<sup>a,b</sup></b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	0.288	0.00	0.00	0.00000115
Larvae	9.17	0.00	0.00	0.00441
Juvenile	2.38	0.00	0.00	0.0330
Age 1+	1.10	0.0066	1.0	0.208
Age 2+	0.924	0.082	1.0	0.562
Age 3+	0.200	0.20	1.0	0.997
Age 4+	0.200	0.33	1.0	1.42
Age 5+	0.200	0.33	1.0	1.78
Age 6+	0.200	0.33	1.0	2.07
Age 7+	0.200	0.33	1.0	2.29
Age 8+	0.200	0.33	1.0	2.45
Age 9+	0.200	0.33	1.0	2.57
Age 10+	0.200	0.33	1.0	2.65
Age 11+	0.200	0.33	1.0	2.71
Age 12+	0.200	0.33	1.0	2.75
Age 13+	0.200	0.33	1.0	2.78
Age 14+	0.200	0.33	1.0	2.80
Age 15+	0.200	0.33	1.0	2.82
Age 16+	0.200	0.33	1.0	2.83

<sup>a</sup> Includes fourspot flounder, smooth flounder, witch flounder, yellowtail flounder, and other flounder not identified to species.

<sup>b</sup> Life history parameters applied to losses from Seabrook and Pilgrim.

Sources: Able and Fahay, 1998; Colarusso, 2000; and PG&E National Energy Group, 2001.

<b>Table C1-43: Other Commercial Species Life History Parameters<sup>a</sup></b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	2.08	0	0	0.000000716
Larvae	5.71	0	0	0.00000204
Juvenile	2.85	0	0	0.000746
Age 1+	0.450	0	0	0.0937
Age 2+	0.450	0.80	0.50	0.356
Age 3+	0.450	0.80	1.0	0.679
Age 4+	0.450	0.80	1.0	0.974
Age 5+	0.450	0.80	1.0	1.21
Age 6+	0.450	0.80	1.0	1.38

<sup>a</sup> Includes goosefish, redfish, spot, and wolffish.

Sources: Able and Fahay, 1998; ASMFC, 2001b; Durbin et al., 1983; Entergy Nuclear Generation Company, 2000; PSE&G, 1999; Ruppert et al., 1985; and U.S. Fish and Wildlife Services, 1978.

**Table C1-44: Other Recreational Species Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.08	0	0	0.000000716
Larvae	5.71	0	0	0.00000204
Juvenile	2.85	0	0	0.000746
Age 1+	0.450	0	0	0.0937
Age 2+	0.450	0.80	0.50	0.356
Age 3+	0.450	0.80	1.0	0.679
Age 4+	0.450	0.80	1.0	0.974
Age 5+	0.450	0.80	1.0	1.21
Age 6+	0.450	0.80	1.0	1.38

<sup>a</sup> Includes Atlantic torpedo, blue runner, cownose ray, dusky smooth hound, flathead mullet, northern puffer, smooth dogfish, striped cusk-eel, white catfish, and white mullet.

Sources: Able and Fahay, 1998; ASMFC, 2001b; Durbin et al., 1983; Entergy Nuclear Generation Company, 2000; PSE&G, 1999; Ruppert et al., 1985; and U.S. Fish and Wildlife Service, 1978.

**Table C1-45: Other Rec/Com Species Life History Parameters<sup>a</sup>**

Stage Name	Natural Mortality (per stage)	Fishing Mortality (per stage)	Fraction Vulnerable to Fishery	Weight (lbs)
Eggs	2.08	0	0	0.000000716
Larvae	5.71	0	0	0.00000204
Juvenile 1	1.43	0	0	0.000746
Juvenile 2	1.43	0	0	0.0472
Age 1+	0.450	0	0	0.0937
Age 2+	0.450	0.80	0.50	0.356
Age 3+	0.450	0.80	1.0	0.679
Age 4+	0.450	0.80	1.0	0.974
Age 5+	0.450	0.80	1.0	1.21
Age 6+	0.450	0.80	1.0	1.38

<sup>a</sup> Includes American eel, black sea bass, conger eel, and piked dogfish.

Sources: Able and Fahay, 1998; ASMFC, 2001b; Durbin et al., 1983; Entergy Nuclear Generation Company, 2000; PSE&G, 1999; Ruppert et al., 1985; and U.S. Fish and Wildlife Service, 1978.

<b>Table C1-46: Other Forage Species Life History Parameters<sup>a</sup></b>				
<b>Stage Name</b>	<b>Natural Mortality (per stage)</b>	<b>Fishing Mortality (per stage)</b>	<b>Fraction Vulnerable to Fishery</b>	<b>Weight (lbs)</b>
Eggs	1.04	0	0	0.0000000186
Larvae	7.70	0	0	0.00000158
Juvenile	1.29	0	0	0.000480
Age 1+	1.62	0	0	0.00381
Age 2+	1.62	0	0	0.00496
Age 3+	1.62	0	0	0.00505

<sup>a</sup> See Table C1-47 for a list of species.

Sources: Derickson and Price, 1973; and PSE&G, 1999.

<b>Table C1-47: Other Forage Species<sup>a</sup></b>			
African pompano	Cornet fish	Northern shortfin squid	Sea lamprey
Alligatorfish	Crevalle jack	Ocean pout	Sheepshead minnow
Atlantic bigeye	Flying gurnard	Orange filefish	Short bigeye
Atlantic moonfish	Glassesye	Oyster toadfish	Silver rag
Atlantic seasnail	Gulf snailfish	Pearlside	Spotfin butterflyfish
Banded rudderfish	Long finned squid	Planehead filefish	Striped burrfish
Bigeye scad	Lookdown	Rough scad	Trumpetfish
Black ruff	Mackerel scad	Round scad	Wrymouth
Brown trout	Northern sennet	Sand tiger	

<sup>a</sup> Includes other organisms not identified to species.